

# Scanning Electron Microscopy/Microprobe

**Scanning electron microscopy (SEM)/microprobe is used to image surface features that range in size from nanometers to micrometers. Qualitative and quantitative elemental analysis of solids is possible for elements ranging from aluminum to plutonium. The SEM microprobe maps the elemental composition of surfaces.**

## Principle of Technique

In SEM, the surface of the sample is scanned in a two-dimensional raster pattern with an electron beam, in synchronism with a cathode-ray-tube display. Secondary electrons are emitted from the surface in numbers dependent upon the local sample topography. Back-scattered electrons and x rays are also emitted and are characteristics of the elements present. The instrument has a secondary electron detector for producing the photographic images, and back-scattered electron and energy-dispersive x-ray detectors for producing the elemental mapping.

## Samples

**Form.** Solids and powders.

**Size.** 1 mg to several grams; ~3.0 cm in diameter  $\times$  1.7 cm high (maximum).

**Preparation.** Some samples can be examined as received. Nonconducting materials must be coated for SEM examination.

## Limitations

The SEM/microprobe measures elements with atomic number  $Z \geq 11$  (sodium).

The limits of detection are about 100 ppm; they are inversely proportional to  $Z$  and dependent on the sample matrix.

## Estimated Analysis Time

After sample preparation, analysis requires from several minutes to a few hours.

## Capabilities of Related Techniques

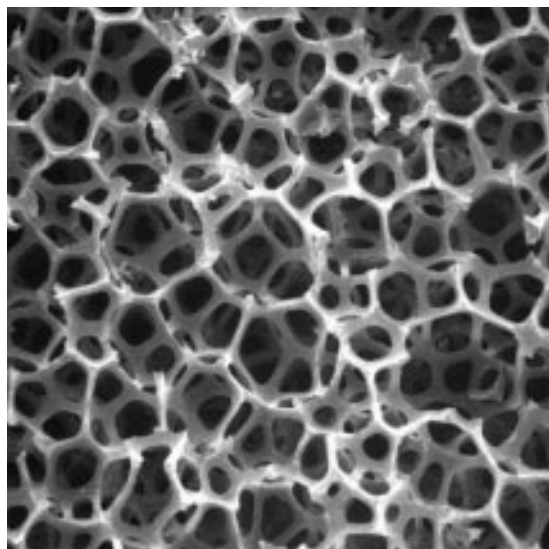
Electron microprobe analysis is sensitive to lower- $Z$  elements [as low as  $Z > 5$  (boron)], and has better elemental resolution than SEM because of its wavelength-dispersive detector.

## Analysis by the Materials Science and Technology Division

In addition to the analysis capabilities operated by ASD within the Plutonium Facility, the Materials Science and Technology Division of C&MS has the capability to perform electron microprobe and SEM analysis of a variety of materials.

## Examples of Applications

- Examinations of metallographically prepared samples at greater magnifications than optical microscopy.
- Identification of flaws in alloys, welds, and ceramics.
- Evaluation of morphology and chemical composition of particles, precipitate phases, grains, and dendrites.
- Identification of contaminants on surfaces.



Low resolution scanning electron microscopy shows structure of carbon foam

